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Colchicine Bibliography

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Introduction

This list of literature is a revision of the compilation mimeographed and distributed in 1946. Many new titles have been added and others have been corrected. Much of this new material was contributed by workers in various parts of the world. We are deeply grateful for their generosity. In spite of the effort to make an entirely complete and correct bibliography we believe there are papers missing from this list that should be added.* We hope these can be called to our attention and added in a future revision of the list. Likewise the correction of any errors of citation will be appreciated.

Unfortunately our efforts to contact Russian Scientists have not been successful, however this situation may improve and a future revision can be devoted to this aspect of the work.

Acknowledgments are due a number of individuals for their contributions to this bibliography. Their names are listed herewith.

Ernst Artschwager, U.S.D.A., Washington, D.C.—A. F. Blakeslee, Smith College, Northampton, Massachusetts.—Thomas P. Bogyo, Budapest XI, Hungary.—J. W. Boyes, McGill University, Montreal, Ontario, Canada.—C. Appelletti, Torino, Italia.—J. W. Cook, The University Glasgow, Scotland.—Ivor Cornman, Sloan Kettering Institute, New York City.—Donald P. Costello, University of N. Carolina, Chapel Hill, N.C.—Haig Dermen, U.S.D.A., Beltsville, Maryland.—Pierre Dustin, Jr., Institute d'Anatomie Laboratoire d'Anatomie Pathologique, Bruxelles, Belgium.—M. L. Gabriel, Brooklyn College, Brooklyn, New York.—Irving Galinsky, University of Wisconsin, Madison, Wis.—Richard Goodwin, Connecticut College, New London, Conn.—Barna Gyorffy, Hungarian Plant Breeding Institute, Magyarovar, Hungary.—Laszlo J. Havas, Hungarian Biological Research Institute, Tihany, Hungary.—Taylor Hinton, Amherst College, Amherst, Mass.—C. Leonard Huskins, Uni-

* Indicates the title was not checked with original paper in our laboratory.

versity of Wisconsin, Madison, Wis.—Margaret Landes, Dept. of Agriculture, Division of Botany, Canada.—Michael Levine, Montefiore Hospital, New York 67, N.Y.—G. Montalenti, Instituto di Genetica, Univ. di Napoli, Italia.—Sophia Satina, Smith College, Northampton, Massachusetts.—Harold Senn, Dept. of Agriculture, Ottawa, Canada.—William Storey, University of Hawaii, Honolulu, Hawaii.—Betty Thomson, Connecticut College, New London, Conn.—Franz Verdoorn, Waltham, Mass.—G. A. W. Wagenaar, V. Neckstraat, Den Haag, Nederland.—Mrs. Lazella, Arnold Arboretum, Jamaica Plains, Mass.—Carol Silver, Northwestern University, Evanston, Illinois.—Marselda Scarff, Northwestern University, Evanston, Illinois.

This bibliography is published in the year of the tenth Anniversary of the effective use of colchicine for researches with plants. An interesting and helpful historical note has been published by Dr. Havas relative to the first publications on the subject. With the permission of the author the following excerpt is reprinted.

"On the tenth anniversary of the discovery of the effects of colchicine in plants.

Owing to the persistance of the erroneous attribution of the discovery of the effects of colchicine in plants the following list, showing the chronological order of the dates of the *first* publications, on the different aspects of the problem, may not be superfluous.

It may be further mentioned that the experiments in question were begun at the Institute of Pathological Anatomy of the University of Bruxelles (Director: Professor A. P. Dustin) on October 14, 1936.

List of first publications.

1. LÁSZLÓ J. HAVAS: Effects of colchicine and of Viscum album preparations upon germination of seeds and growth of seedlings.—*Nature,* **139:** 371, February 27, 1937.

2. A. P. DUSTIN, L. J. HAVAS et F. LITS: Action de la colchicine sur les divisions cellulaires chez les végétaux.—*C. R. Assoc. Anatomistes,* 1–5, Marseille, March 21, 1937.

3. P. et N. GAVAUDAN et N. POMRIASKINSKY—KOBOZIEFF: Sur l'influence de la colchicine sur la caryocynèse dans les méristèmes radiculaires de l'Allium cepa.—*C. R. Soc. Biol.* (Paris), CXXV, 705, June 26, 1937.

4. LÁSZLÓ J. HAVAS: Colchicine, "Phytocarcinomata" and plant hormones.—*Nature,* **140:** 191, July 31, 1937.

5. A. F. BLAKESLEE: Dédoublement du nombre des chromosomes chez les plantes par traitement chimique.—*C. R. Acad. Sci.* **205:** 476, September 13, 1937.

(See also for the correct history of early colchicine research: J. M. KRYTHE and S. J. WELLENSIEK: Five years of colchicine research.—Bibliographia Genetica, XIV, No. 1, **77**: 1–132, 1942.)

LÁSZLÓ J. HAVAS
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October 14, 1946.

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Supplement*

P. DUSTIN, JR.

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The effect of colchicine on mitosis in animal cells was discovered in 1934, in Professor A. P. Dustin's laboratory, by F. Lits (C. R. Soc. Biol. **115**: 1421–1422, 1934). In 1937 the first paper relating the disturbances of mitosis in plant cells was published by A. P. Dustin, L. Havas and F. Lits (C. R. Ass. Anatomistes, Marseille, 21–25 mars 1937, **32**: 177–181). Shortly after the polyploidizing action of colchicine was recognized by A. F. Blakeslee (C. R. Acad. Sci. Paris **205**: 476–479). Since 1937, a great number of papers have been written on the various effects of colchicine. The greatest number refers to the production of polyploids and amphidiploids in plants. Some other fields, for instance the biochemical actions of colchicine and its effects on enzymes, have hardly been prospected.

It was the intention of Professor A. P. Dustin to write a monograph on the accumulated data on colchicine, and many references were gathered for that purpose. After his death in 1942, I continued this bibliographic work under the unfavorable conditions of the German occupation of Belgium.

It was thus with greatest interest that I read Dr. Eigsti's valuable "Literature on Colchicine." A comparison with our references showed that more than 200 were missing from our files, and also that a similar number had been indexed here and not by Dr. Eigsti. It is a list of these that I present in this "Supplement."** I hope that they will be of some help to all engaged in colchicine work. Though nearly a thousand references are now indexed, I do not doubt that the list is far from being complete, and I sincerely hope that further supplements will be added to Dr. Eigsti's important work. This exchange of references is one of the stimulating aspects of peaceful and truly international science.

Brussels, December 1946.

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* Dr. P. Dustin Jr. of the Laboratoire d'Anatomie Pathologique, Université Libre de ruxelles, 97 rue aux Laines, Bruxelles, Belgium kindly furnished a list of papers not included in the original list of 1946. His comments and the list of papers submitted are here appended. O. J. EIGSTI.

** This list was completed in November, 1946. Many foreign periodicals of the period 1941–46 are not yet available. It is increasingly difficult to discover all papers in which colchicine is mentioned. The alkaloid is becoming more and more a tool, for instance in endocrinology, and as such is not brought out in the title of the publication.

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Studies in the Gasteromycetes XV. Notes on New or Rare Species of Tylostoma

W. H. Long

This paper discusses 8 old, but little known, species of *Tylostoma* and describes 7 new ones. The following is a discussion of each of these species with their technical descriptions and distributions. Of the 8 old species, 4 have tubular mouths, 2 fibrillose, 1 indefinite, and 1 a valvate mouth; while of the new species, 4 have tubular mouths, 2 fibrillose, and 1 a valvate mouth.

Tylostoma verrucosum Morgan, Jour. Cin. Soc. Nat. Hist. **12**: 164, 1890.

Figs. 1–2

Sporophore consisting of stipe, sporocarp and large bulbous base. *Sporocarp* subglobose, 7–10 mm. high by 7–12 mm. wide, very firm, attached firmly to stem apex. *Exoperidium* an amorphous hyphal layer covering the endoperidium and firmly attached to it, not deciduous, breaking up into small angular, flat-topped, very thin warts, walnut brown. *Peridial sheath* indefinite, not well differentiated from the exoperidium, persistent. *Endoperidium* tough, membranous, firm, rough from the adhering exoperidium, context white, pecan brown externally. *Mouth* tubular, short, not very prominent, usually slow in opening, about 1 mm. in diameter. *Collar* inconspicuous or with delicate fimbriate points around top of stem. *Stipe* tough, woody, pecan brown, even or slightly tapering to apex, 4–9 cm. (2–4 inches) long, 3–6 mm. thick, scaly, scales mostly gone due to handling but the bases are left. *Volva* none. *Radicating base* none. *Bulb*, large, firm, a mixture of soil, vegetable debris and hyphae 7–20 mm. thick. *Gleba* ferruginous. *Capillitium* hyaline, long, slender, branched, walls thick, septa round or transverse, not or only slightly swollen, 5–6 μ thick. *Spores* irregular globose, 4.2–5 μ in diameter. *Epispore* fulvous verrucose with low blunt warts immersed in a halo. The above description was made from the type material.

Type locality: Ohio, U. S. A.

Habitat: Gregarious in small groups in rich soil in woods.

Distribution: North America, Ohio, *A. P. Morgan*, 4 plants type, in the Morgan Collection in University of Iowa Herbarium. Near Cincinnati, July 26, 1896, *C. G. Lloyd* (*1237*) *vide* Morgan, 2 plants in New York Botanical Garden. Loveland, fragments of 1 plant in the New York Botanical Garden, ex Herb. Agricultural Department, Washington, D. C. Hueston Woods, October 23, 1921, *Bruce Fink*, 1 plant in Lloyd Myc. Coll. *14817*. Preston, July 21, 1896, *C.G. Lloyd*, 6 plants in Lloyd Myc. Coll. *4488*. *C. G. Lloyd*, 1 plant in Mycological Collections Bureau of Plant Industry, remainders from Herbarium of J. B. Ellis, purchased and donated by C. L. Shear. Oregon, 3 miles east of Corvallis, October 20, 1921, *S. M. Zeller*, 1 plant in Lloyd Myc. Coll. *28941*.

Tylostoma verrucosum is a well marked species with its flat-topped verrucose scales (Fig. 2), appearing as if a thin layer of mud had dried on the

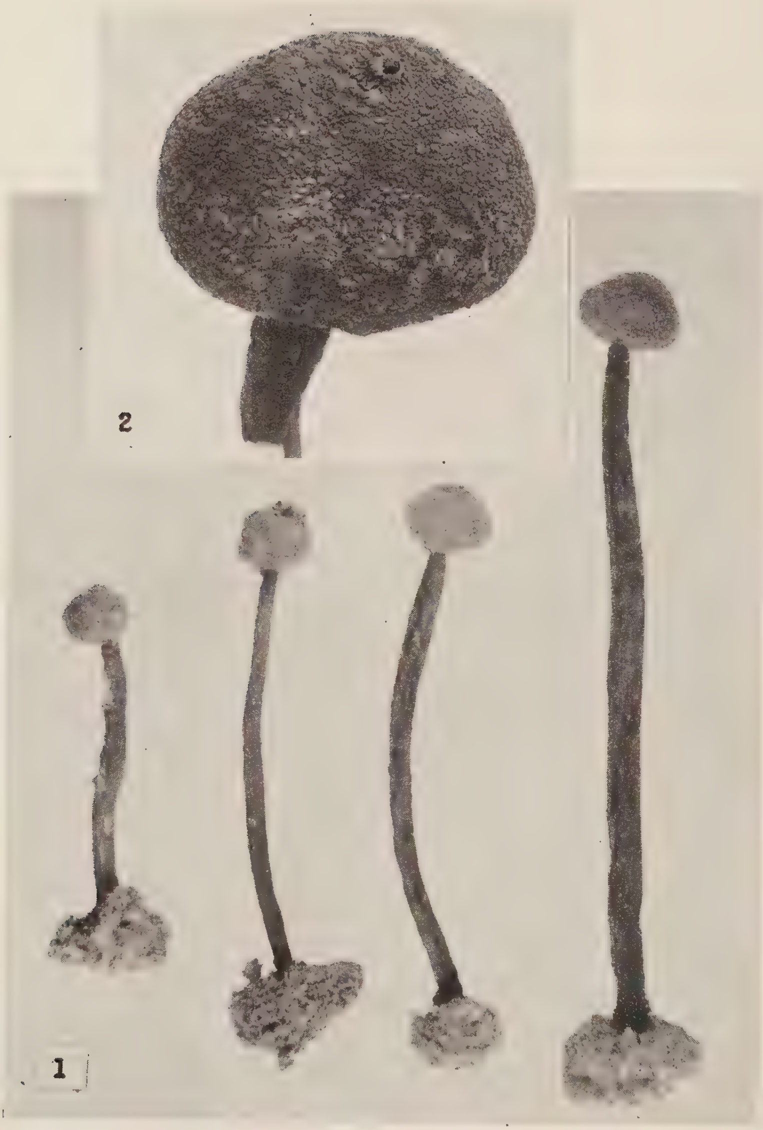


PLATE 1.—Fig. 1. *Tylostoma verrucosum* from type, ×1. Fig. 2. Same, head magnified to show flat warts, ×3 (after Lloyd).

peridium and cracked into small angular pieces, giving the surface a verrucose appearance.

I have examined various collections of this species and find the characters fairly constant, the warts are always persistent, never deciduous. Figure 1 is a photograph of the type material used by Morgan in his original description of this species. This collection was found in Morgan's Herbarium incorrectly labeled by some one, but undoubtedly the type, as his description says 2–4 inches tall, which is the exact size in this collection, also in his figure he shows a white margin to the mouth of the tube and this is evident on the large plant, whereas his general description corresponds with this material. There were no data as to location, date of collection or collector with the specimens, nevertheless it is evident that this is the true type for the above reasons. Also this is the only collection of *Tylostoma verrucosum* present in the Morgan Collections.

The collections issued as *Tylostoma verrucosum* by Prof. D. Tr. Savulescu in his Herbarium Mycologicum Romanicum, Fasc. X, no. *495* collected in the District Prahova, Mustenis-Paulesti, 10/IV/1931, by *Tr. Savulescu et Al. V. Alexandri*, 2 plants from the Farlow Herbarium and 2 plants from the Herbarium at Stockholm, Sweden, proved on examination and comparison with the type from Patouillard Herbarium to be *Tylostoma montanum* Pat. and not *T. verrucosum* since the "warts" on the exoperidium were only grains of sand and not true warts.

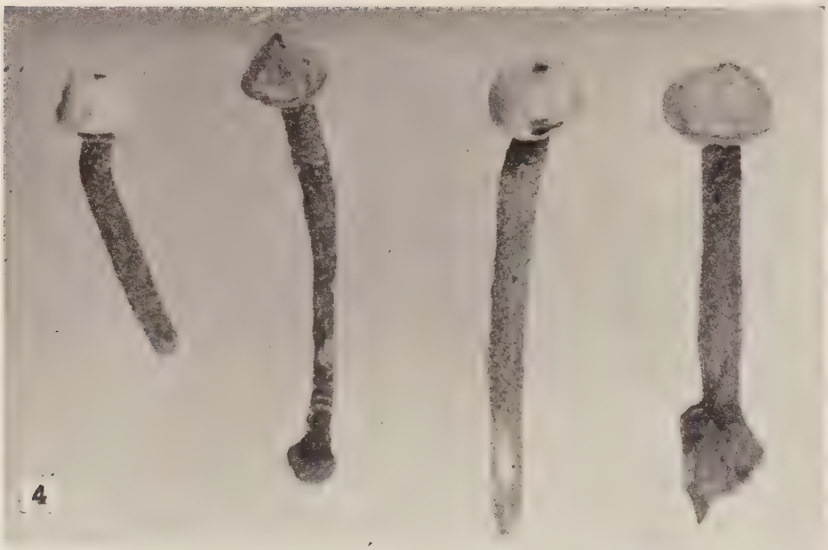
The collection cited by Lloyd (*1906*) as being *Tylostoma verrucosum* collected at Denton, Texas by W. H. Long (his no. *1803*), consisting of 2 plants in Lloyd Myc. Coll. no. *4486*, was examined and proved to be a dark form of *Tylostoma simulans* Lloyd. The 2 plants were covered with dried dirt resembling small warts.

Tylostoma dumeticola sp. nov.

Fig. 3

Sporocarpo subgloboso usque depresso-globoso, 4–12 mm. alto, 6–14 mm. lato. *Exoperidio* in verrucas, minutas, densas, brunneas rumpenti. *Endoperidio* papyraceo, brunneo, facile collapso. *Ore* tubulato, non prominenti, minuto. *Stipite* pertenui, fragili, 3–7 cm. alto, 2–4 mm. crasso, brunneo, squamo-lacerto. *Capillitio* hyalino, ad septas transversas incrassato. *Sporis* sugblobosis echinulatis, 5–6 μ diam. *Episporio* fulvo, valde verrucoso.

Sporophore having sporocarp, stipe and bulbous base. *Sporocarp* subglobose to depressed-globose, 4–12 mm. tall by 6–14 mm. wide much collapsed, firmly attached to stem apex. *Exoperidium* a layer of hyphae attached to endoperidium, breaking into very minute tubercular, pointed (not flat) warts, not visible to naked eye but seen with aid of a good hand lens, pecan brown to Vandyke brown, deciduous especially on upper half



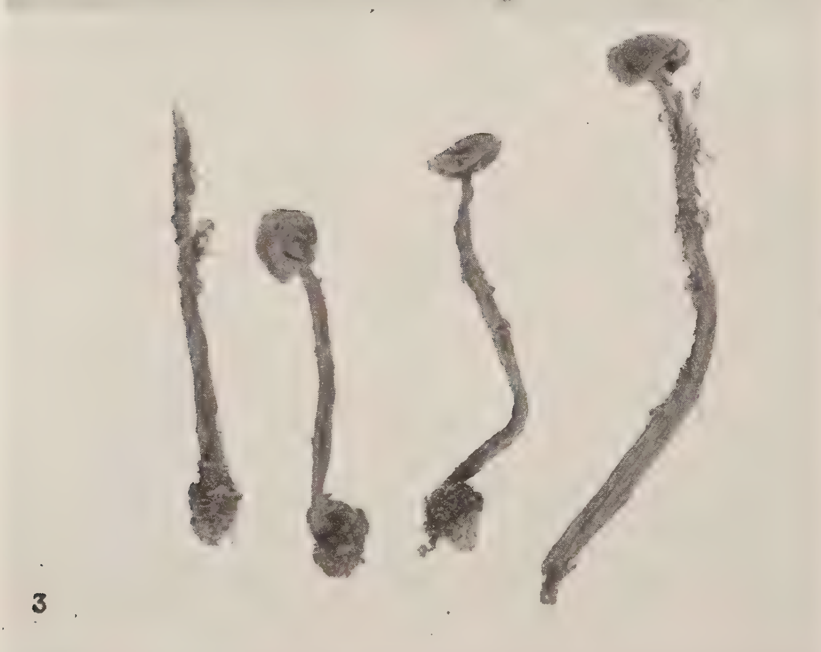


PLATE 2.—Fig. 3. *Tylostoma dumeticola*, ×1. Fig. 4. *T. jourdani*, ×1.

in age. *Peridial sheath* indefinite, not well differentiated from the exoperidium, apparently not warted on some plants, 3–5 mm. broad, persistent. *Endoperidium* papyraceous, easily collapsing, rough from the adhering fragments of the exoperidium, pecan brown. *Mouth* small, tubular, not prominent about 1 mm. in diameter. *Collar* inconspicuous, 1 mm. from stem without any lacerate points. *Stipe* very slender, fragile, easily breaking, pecan brown, scaly, with stringy fibrillose peeling scales (Fig. 3), even to very slightly tapering upward, 3–7 cm. long by 2–4 mm. thick, often striate on lower half under scales. *Bulb* of leaf debris and hyphae, 6–12 mm. thick. *Volva* none. *Radicating base* none. *Gleba* cinnamon. *Capillitium* hyaline, branched, septa transverse 4.2–5.6 μ thick, with abrupt globoid swollen nodes, lumen medium, no halo. *Spores*, subglobose strongly echinate, walls brown, 5–6 μ.

Habitat: In groups in leaf debris and soil in jungle.

Distribution: SOUTH AMERICA. Brazil, Rev. J. Rick, 2 plants in Lloyd Myc. Coll. no. *4487*. *Rev. J. Rick*, no. *111*, 2 plants in Lloyd Myc. Coll. no. *50915*. Sao Leopoldo, Rick Fungi Austro-Americani, 1908, Rick no. *277*, 2 plants in New York Botanical Garden (from Farlow Herb.) and 1 plant (Rick no. *277*), in Farlow Herbarium. Bono Principio, Municipio, Montenegro, Rick Expeditions in Brazil, October 1928, 8 plants and fragments of 5 stems in Farlow Herbarium TYPE, and another collection from same area having 10 plants with sporophores, 10 broken stems with attached bases and 10 fragments of stems. Rio Grande do Sul, Sao Leopoldo, Rick Expeditions in Brazil, 1931, 1 plant in Farlow Herbarium.

This species was originally included in *Tylostoma verrucosum* and is so listed in all the herbaria I have examined, but am sure it does not belong to this species. A comparison of the characters and figures of the two shows plainly the differences between them. *T. dumeticola* has a deciduous exoperidium with very minute tuberculate pointed warts, invisible to the naked eye, a flaccid easily collapsing sporocarp, very slender, fragile stems with stringy fibrillose scales, strongly echinate spores, no halo, septa swollen and globoid.

TYLOSTOMA BONIANUM Pat. Bull. Soc. Myc. France **8**: 49, 1892.

Figs. 5–7

Sporophore consisting of sporocarp, stipe and bulbous base. *Sporocarp* subglobose to depressed-globose, 6–12 mm. tall by 10–15 mm. wide, firmly attached to stem apex, easily collapsing. *Exoperidium* a thin layer of hyphae, breaking up into very small granular to tuberculate warts, pecan brown to walnut brown, slowly and irregularly deciduous over upper part of head leaving whitish scars on head. *Peridial sheath* similar and continuous with the exoperidium, persistent, covered with small warts concolorous with the endoperidium. *Endoperidium* rough from the remains of the exoperidium, with whitish scars (Fig. 6) where the warts have shed, light ochraceous buff, membranous, often collapsing. *Mouth* tubular, circular, flaring at top, about 2 mm. wide, conspicuous. *Collar* inconspicuous, about

PLATE 3.—Fig. 5. *Tylostoma bonianum* from Hawaii, ×1. Fig. 6. Same, head enlarged showing white scars, ×3. Fig. 7. Same, cotype from near Tonkin, showing white scars on head×3. Fig. 8. *T. rivulosum* from Hawaii, ×1.

1 mm. from stem. *Stipe* woody, even, terete, lumen small, scaly above with small appressed scales below, striate beneath scales, pecan brown, 2–4 cm. tall by 3–5 mm. thick. *Bulb* 6–15 mm. thick, of hyphae and sand. *Gleba* tawny. *Capillitium* hyaline, branched, 4–7 mm. thick, lumen small, very uneven in thickness, septa transverse, not swollen, 1 end of thread at septum often thicker than other. *Spores* globose 4.2–5.6 μ with halo. *Epispore* distinctly verrucose, warts hyaline, short, in halo.

Habitat: In groups in loose soil.

Distribution: AFRICA AND HAWAII. Hawaii, Oahu, March 14, 1916, *C. N. Forbes*, Coral plain below Ewa Mill, J. Sisal, from Bernice Pauahi Bishop Museum Herbarium No. *2756.0*, 15 plants in Lloyd Myc. Coll. no. *24517* under name *Tylostoma verrucosum*. Kanaihopais, July 15, 1935, *Otto Degner*, in arid rich rocky soil covered with lantana and weeds, 6 plants (very old and weatheied) in the Bernice Pauahi Bishop Herbarium no. *9983* under name of *Tulostoma campestre.*

I have compared the first named collection with the co-type (Fig. 7) from near Tonkin, China and find that it agrees fairly well with this species hence I am placing it under *T. bonianum.* The description here given is made from the Hawaiian material.

TYLOSTOMA JOURDANI Pat. Rev. Myc. **8**: 143, 1886.

Fig. 4

1901. *Tylostoma albican* White, Bull. Tor. Club **28**: 428.
1920. *Tylostoma mohavei* Lloyd, Myc. Writ. **6**: 992.

Sporophore having sporocarp, stipe and bulbous base. *Sporocarp* subglobose to depressed-globose, 7–10 mm. tall by 10–15 mm. wide, firmly attached to stem apex. *Exoperidium* granular, completely deciduous. *Peridial sheath* a band of hyphae and dirt, 5–6 mm. wide, persistent. *Endoperidium* smooth, tough, membranous, pinkish buff to pinkish cinnamon. *Mouth* tubular, prominent, enlarged at base, circular about 1 mm. in diameter. *Collar* prominent on some plants close to stem, on others clasping the stem. *Stipe* $1\frac{1}{2}$–7 cm. long, usual size 3–5 cm. by 4–6 mm. thick, stout, usually even but a few tapering to base, woody, dingy white, some stems covered with dirt and mycelium as if mildewed, others scaly, a few nearly smooth. *Volva* none. *Radicating base* none. *Bulb* a mass of hyphae and dirt, 7–10 mm. thick, many stems with bases broken off and gone. *Gleba* ferruginous. *Capillitium* hyaline, thicker than spores nearly solid, septa swollen. *Spores* subglobose, subhyaline, 4.2–5.6 μ in diameter, apiculate, 1-guttulate. *Epispore* nearly smooth. The above technical description was made from material collected on Granquist Ranch near Lancaster, California.

Habitat: Solitary or rarely caespitose, in open areas in sandy-clay soil between bunches of desert vegetation, in arid regions.

Distribution: AFRICA. NORTH AMERICA. California, San Bernardino County, near Blythe Junction, April 2, 1920, *P. A. Munz*, 3 plants in Lloyd Myc. Coll. No. 13637 as *Tylostoma mohavei* Lloyd, TYPE for this species. Los Angeles County near Lancaster, on Granquist Ranch, August

24–26, 1939, *W. H. Long*, 19 plants no. *8438*. Hesperia, May 13, 1922 comm. *C. R. Orcutt* fragments of 2 plants in New York Botanical Garden no. *98*. Palm Springs, *W. H. Long*, September 26, 1939, 3 plants no. *8383*. New Mexico, Dona Ana County, Jornado Experimental Range, May 2, 1937, W. H. Long, 1 plant no. *9149*, November 12, 1938, 1 plant no. *8278*, October 2, 1939, 3 plants no. *9185*.

A comparison of this collection (no. 8438) with authentic material of *Tylostoma jourdani* from the Patouillard Herbarium, collected at Biskra, Africa, shows that the 2 collections belong to the same species. The type of *Tylostoma mohavei* Lloyd was also compared with this African collection and proved to be the same. *Tylostoma albicans* White type material was compared with the African plants and the two are very similar, the plants of *T. albicans* were more slender with smaller sporocarps but otherwise about the same, hence I have included it as a synonym of *T. jourdani*.

The type of *T. mohavei* consists of 3 plants, the bases of all were broken off and gone, one plant was apparently nearly full length but the other 2 were broken about the middle of their stems with the lower portions gone.

Tylostoma rivulosum sp. nov.

Fig. 8

Sporocarpo subgloboso usque depresso-globoso, 7–13 mm. alto, 10–22 mm. lato. *Exoperidio* pulverulento, ex parte secedenti. *Endoperidio* duro, cartilaginoso, rivuloso usque punctato, fulvo usque avellaneo. *Ore* tubulato, plus minusve lacerato, prominulo. *Stipite* duro, corneo, $1\frac{1}{2}$-4 cm. alto, 3–5 mm. crasso, luteo usque brunneo. *Sporis* globosis 4.5–5.6 μ diam. *Episporio* verrucoso.

Sporophore having sporocarp, stipe and slightly enlarged base. *Sporocarp* subglobose to depressed-globose, 7–13 mm. tall by 10–22 mm. wide firmly attached to stem apex, very firm and solid when fresh. *Exoperidium* granular, early deciduous. *Peridial sheath* a band of dirt and hyphae, 5–6 mm. wide with a very irregular border, more or less persistent. *Endoperidium* rivulose, somewhat pitted on some plants, tawny to hazel, often dingy white on old weathered plants, sometimes tawny on one side and dingy white on other side of same head, as if the head had been bleached on side lying on ground, cartilaginous, firm, tough. *Mouth* tubular, circular to ellipsoid, with very narrow tubular border, 2 mm. wide by 8 mm. long, more or less lacerate with the narrow mouth borders gone on some plants. *Collar* inconspicuous, clasping stem, not easily separating from it. *Stipe* very hard, corneous, even, terete to fusiform on 1 plant, nearly solid, usually covered with coarse grains of blackish sand above, but lower half and base free of sandy particles and then apricot buff to apricot orange, with pits on naked, exposed stem, this orange part seems to have been slightly viscid or gelatinous when fresh, upper part of stipe when free of sand, Prouts brown to Vandyke brown, $1\frac{1}{2}$–4 cm. tall by 3–5 mm. thick, context light ochraceous buff, not the usual white color, sometimes slightly

flattened, no signs of scales or striae. *Bulb* 5–10 mm. thick of firmly agglutinated hyphae covered with sand particles and a few white hyphae. *Volva* none. *Radicating base* none. *Gleba* ferruginous. *Capillitium* hyaline, walls thick, lumen small, septa rare, very inconspicuous, transverse, not swollen, 1 end of septum often thicker than other. *Spores* globose, 4.5–5.6 μ in diameter. *Epispore* sparsely verrucose.

Habitat: In blackish sandy soil as if of volcanic origin.

Distribution: HAWAIIAN ISLANDS, Honolulu, *C. N. Forbes* in Lloyd Myc. Coll. 11 plants no. *22715* TYPE under name *Tylostoma leveilleanum*.

Tylostoma cineraceum sp. nov.

Fig. 9

Sporocarpo subgloboso, 4–5 mm. alto, 7–12 mm. lato. *Exoperidio* pulverulento, toto secedenti. *Endoperidio* membranaceo, levi, cinereo. *Ore* tubulato, brevissimo. *Stipite* gracili, albo, 6–8½ cm. alto, 4–5 mm. crasso. *Sporis* subglobosis usque ellipticis, 4.2–5 μ diam. *Episporio* verruculoso.

Sporophore having sporocarp and stipe, originating 3–5 cm. below soil surface as evidenced by the clinging dirt now on stems. *Sporocarp* subglobose, small, 4–5 mm. tall by 7–12 mm. wide, firmly attached to stem apex. *Exoperidium* granular, entirely dehiscent on the 3 plants. *Peridial sheath* not evident covered by the flattened sporocarp. *Endoperidium* membranous, smooth to wrinkled, pale drab gray to drab gray. *Mouth* tubular, tube very short and inconspicuous, lacerate on 1 plant. *Collar* hidden by the flattened sporocarp. *Stipe* even, slender, white on upper portion above the dirty lower part of stem, 6–8½ cm. tall by 4–5 mm. thick with appressed scurfy scales, slightly striate under scales, straight. *Volva* none. *Radicating base* none. *Gleba* cinnamon. *Capillitium* hyaline, walls thick, threads unevenly thick, 7–9 μ thick, septa transverse, not swollen, rare. *Spores* oval to subglobose, 1-guttulate, walls thin, 4.5–5 μ diam. *Epispore* plainly verruculose.

Habitat: In soil.

Distribution: ASIA, Afghanistan, *J. E. T. Aitchison*, 11-4-1885; 3 plants TYPE, no. *203* (Aitchison), now in Herb. Hort. Kew, England under name *Tylostoma Wightii*. This is surely not the true *T. Wightii* as a comparison with the type at Kew shows.

Tylostoma orogrande sp. nov.

Fig. 10

Sporocarpo subgloboso, 10–15 mm. alto, 10–22 mm. lato. *Exoperidio* pulverulento, lente et imperfecte secedenti, cinnamomeo. *Endoperidio* membranaceo, duro, luteo. *Ore* tubulato, grandi et robusto, prominenti, 3–5 mm. diam. *Stipite* lignoso, 4–6 cm. alto, 4–7 mm. crasso, brunneo, squamoso. *Capillitio* hyalino, multo ramoso, ad septas crassissimo. *Sporis* ellipticis usque subglobosis, 6–7×7–9 μ diam. *Episporio* brunneo, verrucoso.

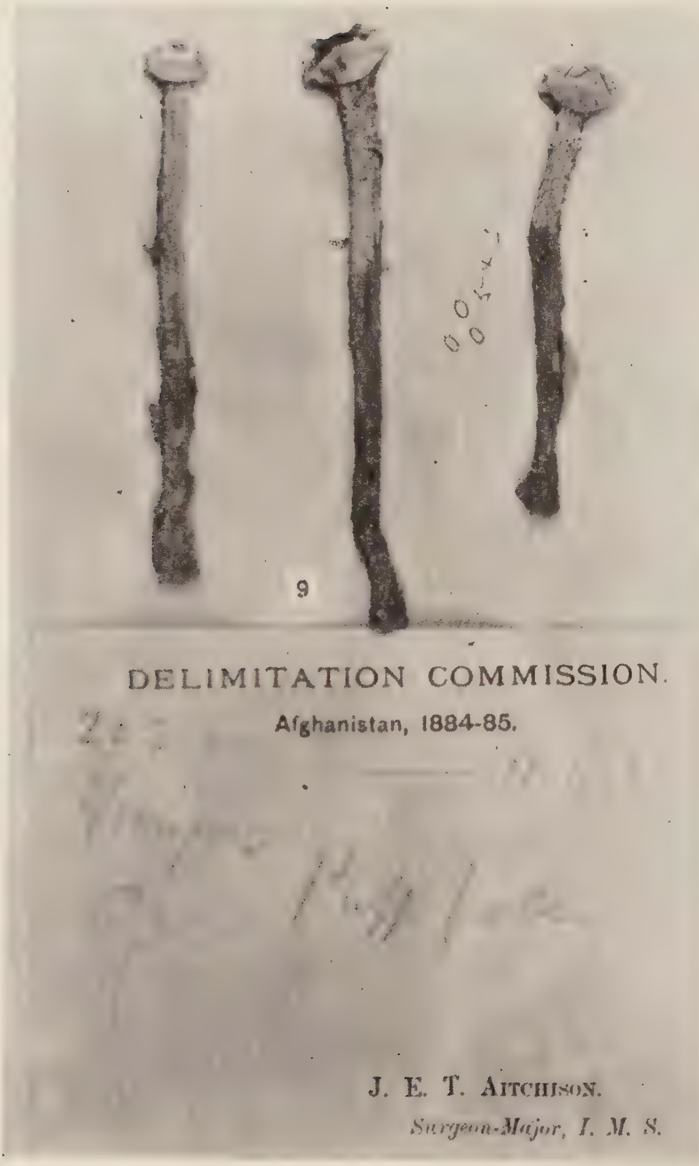


PLATE 4. —Fig. 9. *Tylostoma cineraceum* from Afghanistan, ×1.

Sporophore having stipe, sporocarp and bulbous base, originating 3–5 cm. below surface of soil. *Sporocarp* subglobose, very large 10–15 mm. tall by 10–25 mm. wide, with a mottled appearance, firmly attached to stem apex. *Exoperidium* of granular type, consisting of an outer layer of adobe and hyphae and a very thin amorphous inner lay of hyphae, cinnamon, and tightly cemented to endoperidium, slowly and imperfectly deciduous, wearing away in patches. *Peridial sheath* a band of dirt and hyphae, 5–10 mm. wide, prominent, persistent. *Endoperidium* light buff to cartridge buff, membranous, tough, rough from the adhering fragments of the exoperidium, giving the surface a mottled appearance. *Mouth* tubular, protruding, more or less uneven and often finely lacerate, usually circular but sometimes elliptic, very large and stout, 3–5 mm. in diameter, lips very firm and persistent. *Collar* inconspicuous, 1–2 mm. distant from stem. *Stipe* 4–6 cm. tall by 4–7 mm. thick, terete, even, walnut brown, scaly with large prominent scales, especially on upper half, pointing upward, walls thick, woody about 2 mm. thick with a small lumen 1 mm. in diameter, with adobe adhering to lower part, often obscuring the scales. *Bulb* 6–15 mm. thick of clay and hyphae with a woody core. *Volva* none. *Radicating base* none. *Gleba* ferruginous. *Capillitium* hyaline, much branched, side branches 3–4 μ thick, main trunk 4.5–5.6 μ, lumen none, septa transverse, much swollen, 7–9 mμ thick. *Spores* subglobose to oval, 6.6–8.4 for globose, $6–7 \times 7–8$ μ for oval ones. *Epispore* verrucose, chestnut brown, outer layer apparently gelatinous.

Habitat: Gregarious in heavy clay soil on unshaded areas.

Distribution: New Mexico, Lincoln County, near Jicarilla, elevation, 6560 feet, October 31, 1941, *David J. Stouffer*, 26 plants no. *9863* type. Near Corona, elevation 6800 feet, July 18, 1941, *David J. Stouffer*, 5 plants no. *9838*. Torrance County, on mesa west of Willlard, elevation 5900 feet. October 2, 1941 David J. Stouffer, 5 plants, no. *9839*.

TYLOSTOMA INVOLUCRATUM Long, Mycologia **36**: 330. 1944.

On an expedition to the Gulf of California under the auspices of the California Academy of Science in 1921 a species of *Tylostoma* was found by Ivan M. Johnston (his no. *107*) on a rocky hillside of Monserrate Island. There were 2 plants in the collection and one plant was sent to C. G. Lloyd for identification. I have examined the plant sent to Lloyd and find that it is a small but typical specimen of *Tylostoma involucratum*. The fragments of the membrane of the exoperidium are still very evident on the lower half of the sporocarp. This specimen is now in the Lloyd Myc. Coll. no. *4490* under the name, *Tylostoma occidentale*. This extends the range of this species to the islands adjacent to California.

TYLOSTOMA FINKII Lloyd, Myc. Writ. **7**: 1169. 1923.

The type material of this species (Lloyd no. *32443*), consists of 5 old, much weathered specimens but with all the essential characters still in-

PLATE 5.—Fig. 10. *Tylostoma orogrande*, ×1. Fig. 11. *T. asperum*, ×1.

tact. It includes the 2 plants shown in Lloyd's figure 2307 of this species. Also in the box with the specimens is the original typewritten description by Lloyd which he later published; there can therefore be no doubt that this is the type material of *Tylostoma Finkii*. I have carefully compared this with the co-type of *T. Lloydii*, his number *34468*, and find that they agree in all major characters. The plants of both species are similar in size, shape, color, mouth parts even to the characteristic white peristome and spores; also both species have membranous exoperidia and the same habitat—under trees in dense leaf debris. A comparison of figure 8, plate 82, showing 4 plants of *T. Lloydii* and figure 1307 on plate 225, showing 2 plants of *T. Finkii* should convince anyone that these photographs represent the same species. In view of the above data, *Tylostoma Finkii* Lloyd becomes a synonym of *T. Lloydii*.

The finding of *Tylostoma Lloydii* (*T. Finkii*) on the Campus of Miami University at Oxford, Ohio, which is about 30 miles from the type locality near Cincinnati, somewhat extends the range of this rare and unique species.

Coker and Couch (1928) and Johnson (1929) describe certain collections of *Tylostoma* under the name, *T. Finkii*, basing their determinations mainly on spore characters, irrespective of the other features of the plants. The collections they describe have tubular mouths while the true *T. Finkii* has a fibrillose mouth, hence they are not this species, illustrating the fallacy of identifying species of *Tylostoma* on spores alone.

TYLOSTOMA CYCLOPHORUM Lloyd, Myc. Writ. **2** (Tylostomeae) 25, 1906.

Sporophore having sporocarp, stipe and bulbous base. *Sporocarp* subglobose to sometimes depressed-globose, 5–15 mm. tall by 8–19 mm. wide, firmly attached to stem apex. *Exoperidium* thin, membranous, early deciduous, outer surface russet to chestnut brown, inner surface white. *Peridial sheath* membranous, outer surface chestnut brown, with an irregular border, persistent to semi-deciduous. *Endoperidium* smooth or sometimes rough from fragments of the exoperidium, buff pink to cinnamon, membranous. *Mouth* fibrillose, shield-shaped, slightly raised when when young, becoming plane and somewhat enlarged and lacerate with age, circular to elliptic, often elongated with age. *Collar* definite, usually conspicuous pendant around stem, lacerate, russet to chestnut brown, 0–4 mm. long by 1–2 mm. distant from stem. *Stipe* firm, slender, not fragile, even, 1–5 cm. long by $1\frac{1}{2}$–4 mm. thick, smooth or rarely with small appressed scales, hazel to russet. *Bulb* 2–13 mm. across covered with vegetable debris. *Volva* none. *Radicating base* none. *Gleba* ferruginous to cinnamon. *Capillitium* subhyaline, much branched, walls thick, 5.6–8.4 μ thick, septa slightly swollen and colored. *Spores* globose, 4.2–5.2 μ. *Epispore* granular to verruculose.

Habitat: Apparently growing in vegetable debris with dirt envelope around base, which often causes the bulbs to break off and remain in the soil when the plants are collected. Illustrations: Lloyd Myc. Writ. **2:** plate 85, figures 1 and 2.

Distribution: SOUTH AFRICA. *Miss B. Stoneman,* in Lloyd Myc. Coll. *4495,* 3 plants TYPE *Miss A. V. Duthie,* Lloyd Myc. Coll. 6 plants no. *14279,* 6 plants no. *14280.* Miss A. V. Duthie, Stellenbosch, in Lloyd Myc. Coll. 2 plants no. *4494.* 10 plants no. *24519,* 9 plants no. *24520,* July 1915, 7 plants no. *30852.* Transvaal, *Miss A. V. Duthie,* in Lloyd Myc. Coll. 1 plant no. *54734.* Cape Colony, *C. A. O'Connor,* in Lloyd Myc. Col.. 15 plants no. *30833.*

Two collections from P. van der Bijl, Lloyd Myc. Coll. no. *28934* and *28954* from South Africa cited by Stevenson and Cash (*1936*) as *Tylostoma cyclophorum,* proved on examination not to be this species; no. *28934* has a granular sandy exoperidium and tubular mouth, while no. *28954* has a granular sandy exoperidium and unopened mouth. Lloyd has question marks after both of these collections.

Tylostoma asperum sp. nov.

Fig. 11

Sporocarpo subgloboso, 5–6 mm. alto, 6–7 mm. lato, ex apice stipitis facile soluto. *Exoperidio* membranaceo, toto secedenti. *Endoperidio* membranaceo, firmo, scabro, luteo. *Ore* fibrilloso, 2–3 mm. diam. *Stipite* lignoso, brunneo, $2\frac{1}{2}$–4 cm. alto, 2 mm. crasso. *Sporis* subglobosis, 4–4.5 μ diam. *Episporio* verruculoso.

Sporophore having sporocarp, stipe and bulbous base. *Sporocarp* subglobose, 5–6 mm. tall by 6–7 mm. wide, rather easily detached from stem apex and when disjoined is often held in place inside the head by the white mycelial central strand in stem. *Exoperidium* membranous, deciduous in flakes leaving an asperate surface to the endoperidium, caused by whitish remnants of the inner living of the exoperidium, upper surface Vandyke brown inner surface light cinnamon drab. *Peridial sheath* continuous with the exoperidium of same color, thin, membranous, persistent. *Endoperidium* membranous, firm, asperate from the whitish, dried patches of the inner lining of the exoperidium, left when it dehisced, light cinnamon drab to vinaceous buff. *Mouth* fibrillose, plane or slightly raised, with a definite mat, usually circular, 2–3 mm. in diameter. *Collar* inconspicuous, 1 mm. from stem, often fimbriate and pendent around the stem. *Stipe* woody, even or often tapering upward, terete, walnut brown, with small appressed scales, somewhat striate on some stems, $2\frac{1}{2}$–4 cm. long, usual size 3 cm., about 2 mm. thick. *Bulb* 6–15 mm. thick, of white hyphae interwoven with leaf debris. *Gleba* ferruginous. *Capillitium* hyaline, walls thick, lumen small, threads 4–5 mμ thick, septa transverse or rounded, not or only slightly swollen. *Spores* subglobose, some apiculate, 4.2 μ in diameter. *Epispore* verruculose to smooth.

Habitat: Gregarious in debris under junipers.

Distribution: Texas, Austin, near Mt. Bonnell, August 3, 1902, *W. H. Long & A. M. Ferguson*, 30 plants, TYPE no. *11186* Herb. Long; 36 plants cotype no. 830 of Herb. University of Texas; 6 plants *11191* Herb. Long and 7 plants no. 22 Herb. University of Texas; Palo Duro State Park, near Amarillo, October 28, 1934, *Ernest Wright*, 3 plants in Univ. of California Herb. at Berkeley no. *532025* and 3 plants in the New York Botanical Garden, both collections under name *Tylostoma poculatum*. *Tennessee*, Andersonville, January 16, 1943, *Aaron Williams*, from Bureau Plant Industry Herb., in leaf debris under red cedar from Herb. Univ. Tenn. no. *15783*, 2 plants in Herb. Long no. *11431*

Tylostoma polymorphum, sp. nov.

Fig. 12

Sporocarpo ovato, subgloboso, depresso-globoso usque pulvinato, 4–15 mm. alto, 5–20 mm. lato. *Exoperidio* pulverulento-floccoso, demum secedenti. *Endoperidio* membranaceo, eburneo usque sordide albo. *Ore* prominenti, fibrilloso aetate plano et lacerato. *Stipite* lignoso, obeso usque tenui, $1\frac{1}{2}$–3 cm. alto, 3–6 mm. crasso, brunneo. *Sporis* subglobisis usque ellipticis 4.2–4.6 μ diam., interdum apiculatis. *Episporio* levi.

Sporophore having sporocarp, stipe and slightly enlarged base. *Sporocarp*, ovate, subglobose, depressed-globose to pulvinate with flat to concave base, 4–15 mm. tall by 5–20 mm. wide, firmly attached to stem apex. *Exoperidium* a thin granular-hyphae dirt coat, inner layer of white flocci, finally deciduous. *Peridial sheath* persistent, a heavy band of clay and hyphae, 6–8 mm. wide. *Endoperidium* membranous, tough, smooth or rough from adhering fragments of the exoperidium, ivory yellow to pale pinkish buff to dingy white in age. *Mouth* raised when fresh, a fibrillose mat peristome, orbicular to oval, 3×6 mm. on some heads, 3–4 mm. when orbicular, concolorous with the endoperidium, lips friable, easily breaking away with age and becoming irregularly lacerate often with loss of fibrils. *Collar* inconspicuous, more or less clasping the stem then about 1 mm. long, 1–2 mm. from stem on some plants. *Stipe* stout, obese to slender, woody, even or slightly tapering to base, $1\frac{1}{2}$–3 cm. tall by 3–6 mm. thick, rarely sulcate, scales appressed when fresh but often spreading with age, often deciduous, reddish brown (cacao brown), stipe beneath scales concolorous with the endoperidium. *Bulb* 4–10 mm. thick, covered with dirt. *Gleba* ferruginous. *Capillitium* hyaline, walls mediumly thick, rarely branched, threads long, wavy, septa not seen. *Spores* subglobose to oval, 1-guttulate, 4.2–4.6 μ in diameter, some apiculate. *Epispore* smooth.

Habitat: Solitary or in small groups usually in clay-hardpan, rarely in sandy soil, often around margins of "live" prairie dog mounds, common on this area.

Distribution: New Mexico, Albuquerque, Bernalillo County, Old Golf Course in Heights July 8, 1920, 9 plants, no. *6941*. Lippett Sandia Plaza Addition and vicinity, about 4 miles from city on N. 4th Street: *W. H. Long*, May 16, 1941, 165 plants no. *9308;* May 30, 1941, 142 plants, no. *9337* and 37 plants no. *9337a;* June 27, 1941, 48 plants no. *9373;* October 16, 1941, 8 plants no. *9824;* May 12, 1942, 4 plants, no. *10250;* 3 plants, no. *10397;* November 29 and December 1, 1942, 36 plants, no. *10411;* December 10, 1942, 78 plants, no. *10410*, December 31, 1942, 35 plants,

PLATE 6. Fig. 12. *Tylostoma polymorphum*, $\times 1$.

no. *10399;* January 31, 1943, 16 plants, no. *10409;* February, 1–8, 1943, 74 plants, no. *10407;* February 13, 1943, 88 plants, no. *10412;* March 31, 1943, 50 plants, no. *10401;* April 2, 1943, 18 plants, no. *10402;* June 20, 1943, 13 plants no. *10367;* June 30, 1943, 16 plants no. *10370;* August 4, 1943, 25 plants, no. *10379;* August 6, 1943, 32 plants, no. *10381*, 54 plants, no. *10385*; August 8, 1943, 16 plants no. *10389*: 12 plants, TYPE no. *10390;* August 11, 1943, 32 plants, no. *10391;* August 12, 1943, 10 plants, No. *10426;* August 30, 1943, 32 plants no. *10428;* September 18, 1943 6 plants, no. *10436;* October 2, 1943, 13 plants, no. *10443;* April 19, 1945, 47 plants, no. *11045;* August 19, 1945, 15 plants no. *11046;* 35 plants no. *11047;* April 19, 1945, 69 plants, no. *11044;* August 19, 1945, 25 plants, no. *11055;* 16 plants, no. *11057;* 42 plants no. *11058;* May 16, 1946, *W. H. Long and A. G. Miller*, 23 plants, no. *11128; W. H. Long* May 19, 1946, 33 plants, no. *11123;* May 20, 1946, 10 plants no. *11126;* July 26, 1946, 44 plants, no. *11141.*

TYLOSTOMA LEVEILLEANUM Mont. in Gaud. Voy. Bonite Crypt., p. 200. 1844–46.

Fig. 13

1846. *Schizostoma leveilleanum* Lév. Ann. Soc. Nat. Bot. III, **5**: 165. 1846.

Sporophore having sporocarp, stipe and bulbous base. *Sporocarp* depressed-globose, 8–10 mm. tall by 18–28 mm. wide, firmly attached to stem apex, heads firm. *Exoperidium* a thin persistent layer of hyphae, breaking up into very small scales, umber brown. *Peridial sheath* a very thin inconspicuous membrane, blackish brown, persistent. *Endoperidium* rough from exoperidial scales, sayal brown to cinnamon under the scales, tough, membranous. *Mouth* indefinite, a narrow elliptical opening ½ mm. wide by 1 mm. long on 1 head, very inconspicuous, no signs of a mouth on the half head, only a slight depression covered with flat scales where the mouth should be. *Collar* inconspicuous, about 1½ mm. from stem. *Stipe* very hard, even, terete on stem with head, flattened in a longitudinal furrow with incurved edges on the other stem, blackish brown, smooth, no signs of scales or striae, 2–3 cm. tall by 3 mm. thick. *Bulb* 10–12 mm. thick of hyphae and sand. *Volva* none. *Radicating base* none. *Gleba* mikado brown. *Capillitium* subhyaline, 5.6–7 μ thick, threads of uneven thickness, walls mediumly thick, septa transverse, not swollen, rare, lumen of uneven thickness. *Spores* globose with a strong halo, 7–8 μ with halo, 5–5.7 μ without halo. *Epispore* with sparsely digitiform spines embedded in a prominent gelatinous-like halo which are often deciduous under pressure on cover glass, halo very pronounced in a 25% solution of chloral hydrate.

Habitat: In soil.

Distribution: Hawaii, collector *Gaudichaud* comm. *P. Hariot* in Lloyd Myc. Coll. no. *22711* part of TYPE (2 plants).

Other type specimens, dry and in alcohol, are in the museum at Paris according to Lloyd (1906). The collection described above consists of 1 perfect plant, half of a split head and a stem without a head (Fig. 13).

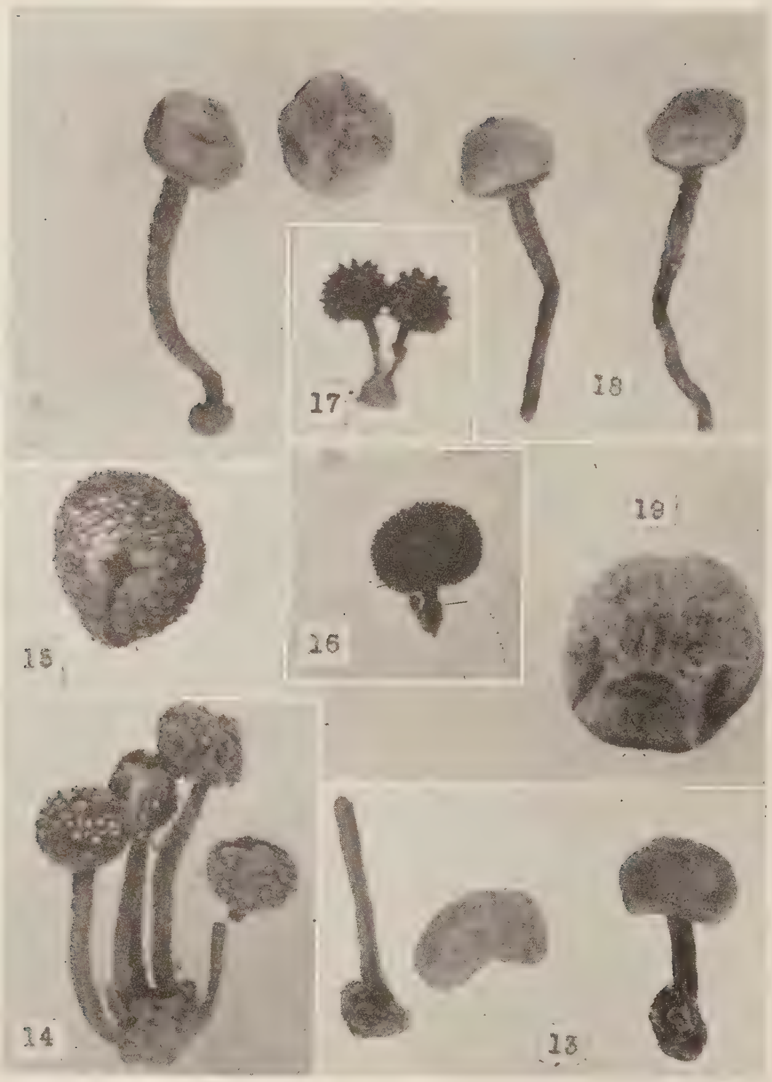


PLATE 7.—Fig. 13. *Tylostoma leveilleanum*, type ×1. Fig. 14. *T. exasperatum* from Malaya, ×1. Fig. 15. Same, from Brazil, head magnified to show volvate stoma, ×2. Fig. 16. Same, from Belgian Congo, ×1. Fig. 17. *T. ridleyi*, type, ×1. Fig. 18. *T. punctilabratum*, ×1. Fig. 19. Same, head magnified to show volvate stoma, ×2.

TYLOSTOMA EXASPERATUM Mont. Ann. Sci. Nat. Bot. II, **8**: 362. 1837.

Figs. 14–17

1846. *Schizostoma exasperatum* Lev. Ann. Sci. Nat. Bot. III, **5**: 165. 1846.

Sporophore having sporocarp, stipe and bulbous base. *Sporocarp* subglobose to depressed-globose, 6–15 mm. tall by 7–20 mm. wide, firmly attached to stem apex. *Exoperidium* consisting of a layer of large conical erect warts on upper half of head (Figs. 16 & 17) often mixed with a few smaller ones, lower half of head with much smaller warts, chestnut brown to usually burnt umber, deciduous in age, especially on upper portion leaving very pronounced whitish scars (Figs. 14 & 15). *Peridial sheath* a continuation of the exoperidium but with smaller warts, persistent, burnt umber. *Endoperidium* membranous with a very soft context, rough from the whitish scars and fragments of the adhering exoperidium, often having a reticulate appearance from the scars leaving rings of the exoperidium when the warts fall off, cinnamon to buff pink. *Mouth* valvate (Fig. 15) of 4–5 irregular, stellate segments of the endoperidium, often defined by sutures before opening, covered with warts when young, forming a peristome 4–6 mm., usual size 5 mm., usually darker than the endoperidium, slightly raised when open. *Collar* inconspicuous, clasping the stem in some plants, inevident in others. *Stipe* $\frac{1}{2}$–4 cm. tall, by 2–4 mm. thick, terete, even, burnt umber to chestnut brown, with prominent small pointed warts which are often deciduous, or with flat scales pointing upward. *Bulb* none. *Radicating base* none. *Gleba* cinnamon to ferruginous. *Capillitium* hyaline, 3–5 mm. thick, septa transverse, not swollen, branches few, walls thin, lumen large. *Spores* globose, 4.5–5.6 μ diam., without halo, 6–7 μ with halo. *Epispore* sparsely digitiform with very prominent halo.

Type locality: North America, Cuba.

Habitat: In groups, often caespitose, on rotting forest debris in forest and jungles.

Distribution: North America; South America; Philippine Islands, Malay Peninsula; Borneo; Africa. NORTH AMERICA, Cuba. 1 plant in New York Botanical Garden. *C. Wright* (his no. *247*) in Fungi Cubenses Wrightiani no. *500*, 2 plants in the New York Botanical Garden, another collection same date, 2 plants in Herbarium Farlow, and 4 plants in Herb. Hort. Kew, England. SOUTH AMERICA: Brazil. *Rev. J. Rick*, 4 plants in Lloyd Myc. Coll. no. *22716*. *L. S. Anderson*, Rick no. *30*, 4 plants in New York Botanical Garden from Herb. Bresadola. *J. Rick*, 1926, 6 plants in Herb. Farlow. *Rick*, no. *30*, 3 plants in Herb. Farlow, from Herb. F. Theissen. Sao Leopoldo, Rick, Fungi Austro-Americani no. *30*, 1904, 2 plants in New York Botanical Garden. Rio Grande do Sul, Sao Leopoldo, Rick Expeditions in Brazil, 1930, 3 plants in Herb. Farlow. Sao Leopoldo, Rick, Fungi Austro-Americani, no. *30*, June 1904, 2 plants in Herb. Farlow. Sao Leopoldo, no. *30*, June 1904, 4 plants in Herb. Farlow purchased from Herb. F. Theissen in 1928. Sta. Catherina, *Fritz Mueller*, September 1889, Ex Shaw School of Botany, 2 plants now in Herb. Farlow. Sta. Catherina, Porto Novo, Rick Expeditions in Brazil no. *562*, 1928, 2 plants now in Herb. Farlow. Argentina; Tucuman, June 1917, no. 13380, 4 plants, Museo de la Plata, Inst. de Bot. C. Spegazzini. PHILLIPINE ISLANDS, Isabela Basilan Island, *H. S. Yates*, November–December 1919, Bureau of Science, no. *26208*, Flora of the Philippines, 2 plants in Lloyd Myc. Coll. no. *22717*. MALAY PENINSULA, Negri Smbilan, locality Uln Bendul, *R. E. Holttum*, November 30, 1922, 4 plants in

Lloyd Myc. Coll. no. *22718;* 2 plants in Herb. Hort. Kew, England. *Africa*. Congo Belge, *Rev. Hyac. Vanderyst*, December 1923, 11 plants in Lloyd Myc. Coll. no. *27628*. BORNEO. Perak, *Ridley*, his no. *8*, 2 plants, Herb. Farlow under name *Tylostoma Ridleyi* TYPE. This collection consists of 2 small caespitose plants (Fig. 17) typical of *Tylostoma exasperatum*.

Tylostoma punctilabratum sp. nov.

Fig. 18

Sporocarpo subgloboso usque depresso-globoso, 8–10 mm. alto, 14–15 mm. lato. *Exoperidio* pulverulento, generaliter secedenti. *Endoperidio* papyraceo, luteo, levi vel ruguloso. *Ore* 3–5 valvato, sub-prominenti, punctilabrato. *Sporis* globosis 5.6–7 μ diam. *Episporio* valde verrucoso.

Sporophore having sporocarp, stipe and bulbous base. *Sporocarp* subglobose to depressed-globose, 8–10 mm. tall by 14–15 mm. wide, firmly attached to stem apex. *Exoperidium* granular, mainly deciduous. *Peridial sheath* a thick prominent band of hyphae and sand, 5–7 mm. wide, persistent. *Endoperidium* papyraceous, more or less flaccid, light buff, smooth to wrinkled. *Mouth* valvate with 3–5 valves (Fig. 19), having a raised, pitted peristome about 4 mm. wide, partially breaking away in age. *Collar* inconspicuous, 1–2 mm. from stem. *Stipe* slender, weak, walls thin, more or less curved, striate near head, rough but not scaly. *Bulb* of sand and hyphae about 6 mm. thick. *Volva* none. *Radicating base* none. *Gleba* cinnamon. *Capillitium* hyaline, walls thick, lumen more or less mere slits, threads uneven, 4.2–7 μ thick, sparingly branched, septa transverse, not swollen, rare. *Spores* 5.6–7 μ diam. usual size 5.6 μ 1-guttulate. *Epispore* strongly verrucose.

Distribution: AFRICA, Algeria, Ain Sefra, sud Oranais, *Dr. R. Maire*, April 1924, Institute of Algeria, 4 plants TYPE in Lloyd Myc. Coll. no. *37758* under name of *Tylostoma volvulatum*. This is a very different plant from the true *T. volvulatum* as the above description shows.

General Remarks: The exoperidia may be classified in 4 divisions: 1-membranous, 2-semi-membranous, 3-granular, while a 4th-hyphal, may be split off from the granular type; when the granular portion is very thin or evanescent and the hyphal portion consists of an amorphous layer covering the endoperidium and firmly attached to it. This 4th type is usually covered with brownish warts. Under this type come the following species: *Tylostoma verrucosum*, *T. dumeticola*, *T. bonianum*, *T. leveilleanum*, *T. exasperatum* and *T. myssooriense*.

The mouths may be as follows: tubular, semi-tubular, fibrillose, sub-fibrillose, indefinite and valvate. The tubular, fibrillose and indefinite need no description as they are well established forms, but the sub-fibrillose, semi-tubular and valvate need to be defined. The sub-fibrillose, are those mouths which have very few fibrils and often merge into the indefinite forms, that is, some of the heads may show few fibrils while other heads in the same collection may have naked indefinite mouths. The semi-tubular

forms are those mouths with a definite elongated very narrow erect border; while the valvate type are those mouths which open in a definite stellate valvate manner (Figs. 15, 19). *Tylostoma exasperatum* is a good example of this valvate type.

ACKNOWLEDGMENTS

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Effects of Selected Chemical Properties of Soils on Protein Content of Sudan Grass[1]

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Introduction

A detailed description of the chemical characteristics of a group of soils in the vicinity of Midland, Douglas County, Kansas, has been published by Wynd and Romig (1), and Wynd and Noggle (2). Wynd and Noggle (3, 4) have described the relationship which existed between the chemical properties of these soils and the growth of oats and rye. More recently, these authors have described the relationship between selected chemical properties of another group of soils in the same general area and the growth of Sudan grass (5). These studies showed that the growth of each of these 3 species of grasses was governed by the amount of replaceable bases in the soil. Even the amount of nitrogen in the soil appeared to be of secondary importance in determining the yield of dry matter of these species, when they were harvested at the jointing stage.

Wynd and Noggle (6, 7) have also reported that concentration of protein in the leaves of oats and rye was governed primarily by the amount of nitrogen in the soil. The total yield of protein in pounds per acre on the other hand was determined largely by the same soil factors which governed growth, i.e., the amount of replaceable bases. The amount of growth, rather than the percentage of protein in the tissue, therefore, appears to govern the total amount of protein produced by oats and rye (6, 7, 8).

The purpose of the present paper is to report observations on the relationships between selected chemical properties of another group of soils in the vicinity of Midland and the protein content of Sudan grass.

Materials and Methods

The materials used in the present study were the same samples of soil and of Sudan grass that were used in the previous study of the relationships between certain chemical characteristics of the soil and the growth of Sudan grass (5). The details of the field observations on the soils and crops and of the chemical analyses of the soils are presented in tables 1 to 4 inclusive in the preceding paper. The individual data may be recognized by the corresponding field numbers. The number of each point in the figures is the last digit of the corresponding field number. The protein values were obtained by multiplying the Kjeldahl nitrogen by 6.25. Since soil surveys

[1] Expenses incurred by the present study were borne in part by a grant from the Cerophyll Laboratories, Inc., Kansas City, Missouri.

of this area have not been published, the soils are loosely grouped into "first bottom" and "upland" soils as described in the previous paper (5).

Experimental Results

RELATIONSHIPS BETWEEN SOIL PROPERTIES AND PROTEIN

Replaceable bases: Data presented in table 1 and figure 1 show that the percentage of protein in Sudan grass grown on the first bottom soils is positively correlated to the amount of replaceable bases in the soil. Figure 2 shows that an even more strongly positive relationship exists between the amount of replaceable bases and the total yield of protein. This high degree of correlation is to be expected since the amounts of replaceable bases are positively related to the yield of dry matter (5) as well as to the concentration of protein in the tissue.

TABLE 1. *The protein content of Sudan grass grown on first bottom soils.*

Field no.	Dry wt., lbs. per acre	Protein	
		%	Yield, lbs. per acre
305	623	21.9	137
306	714	18.6	133
309	537	21.1	114
311	377	15.8	60

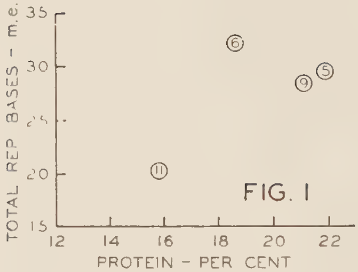
TABLE 2. *The protein content of Sudan grass grown on upland soils.*

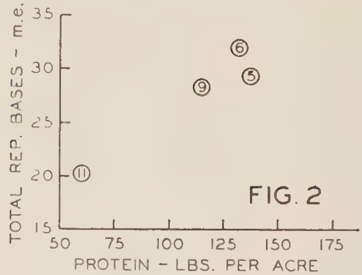
Field no.	Dry wt., lbs. per acre	Protein	
		%	Yield, lbs. per acre
300	680	14.9	102
301	737	22.1	163
302	838	16.8	141
303	1009	14.5	146
304	493	13.6	67
307	958	17.9	172
308	466	15.0	70

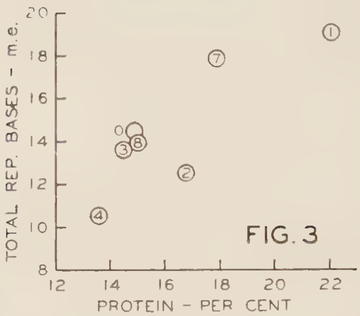
Figures 3 and 4 show that the relationships between the amount of replaceable bases and both the percentage and yield of protein in Sudan grass grown on the upland soils are also strongly positively correlated. The yields represented by points 2 and 3 in figure 4 are too large since it has already been stated (5) that these crops were harvestedfat an unusually advanced stage with respest to the remaining crops in this group.

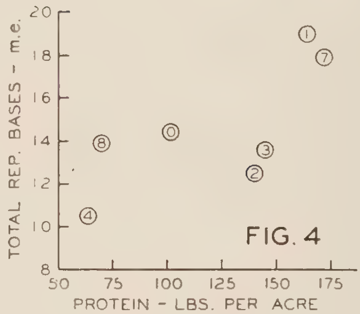
If the data obtained from both first bottom and upland soils are pooled, figure 5 shows that a more or less regular relationship exists between the percentages of protein in the tissue and the amounts of replaceable bases in the soils, in spite of the great chemical differences which exist between these groups of soils. However, figure 6 shows that no such regular relationship exists between the pooled data for the yield of protein. This difference in the effect of the first bottom and upland soils in protein yield is due to the difference in their effects on the yields of dry matter.

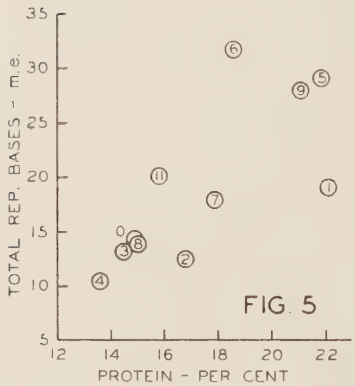
Base exchange capacity: Figures 7 and 8 show that there was no dis-











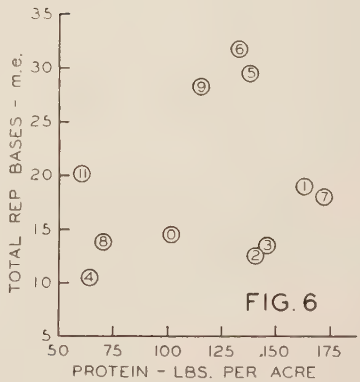


FIG. 1. Relationship between total replaceable bases in first bottom soils and concentrations of protein in Sudan grass.

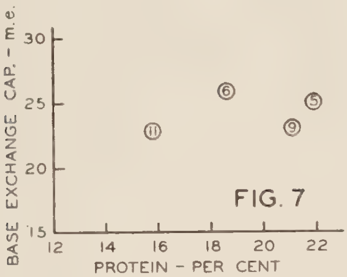
FIG. 2. Relationship between total replaceable bases in first bottom soils and yields of protein by Sudan grass.

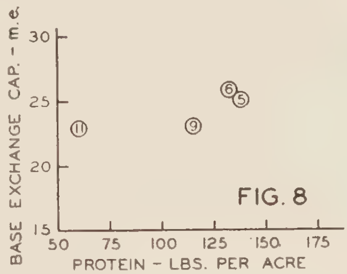
FIG. 3. Relationship between total replaceable bases in upland soils and concentrations of protein in Sudan grass.

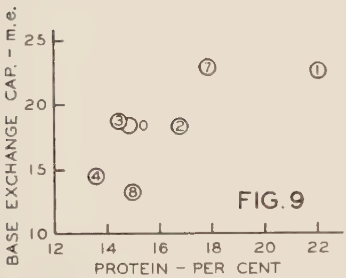
FIG. 4. Relationship between the total replaceable bases in upland soils and yields of protein by Sudan grass.

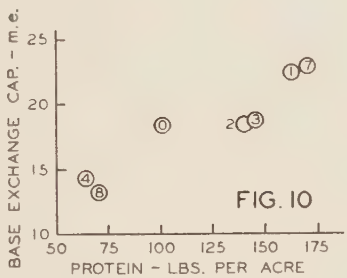
FIG. 5. Relationship between the pooled data of the total replaceable bases in soils and concentrations of protein in Sudan grass.

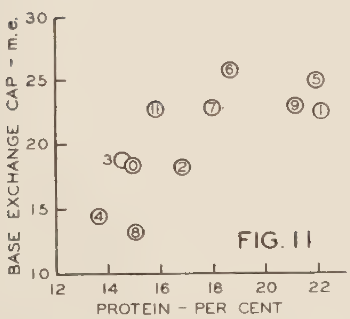
FIG. 6. Relationship between the pooled data of first bottom and upland soils and yields of protein by Sudan grass.











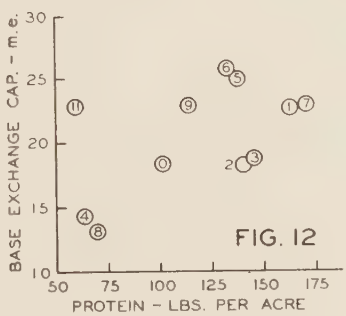


FIG. 7. Relationship between base exchange capacity of first bottom soils and concentrations of protein in Sudan grass.

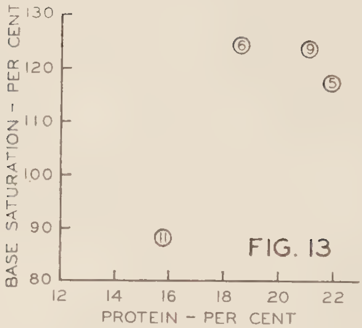
FIG. 8. Relationship between base exchange capacity of first bottom soils and yields of protein by Sudan grass.

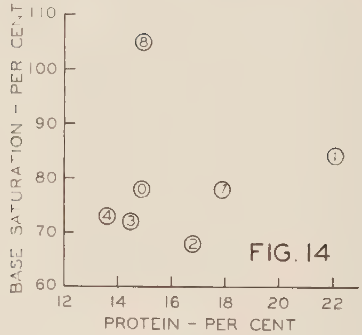
FIG. 9. Relationship between the base exchange capacity of upland soils and concentrations of protein in Sudan grass.

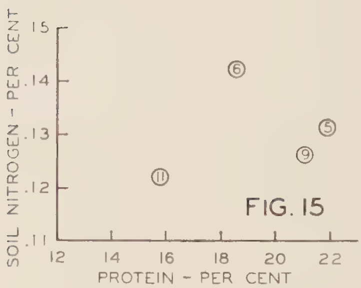
FIG. 10. Relationship between the base exchange capacity of upland soils and yields of protein by Sudan grass.

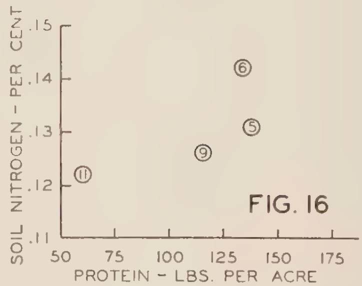
FIG. 11. Relationship between the pooled data for first bottom and upland soils and the concentrations of protein in Sudan grass.

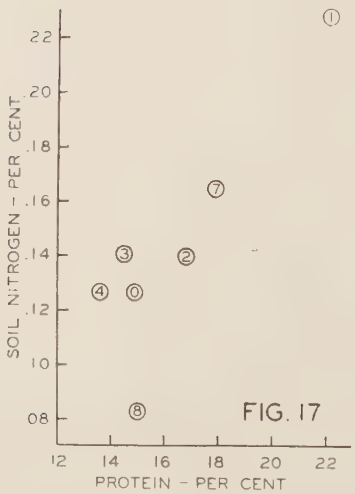
FIG. 12. Relationship between the pooled data of first bottom and upland soils and yield of protein by Sudan grass.











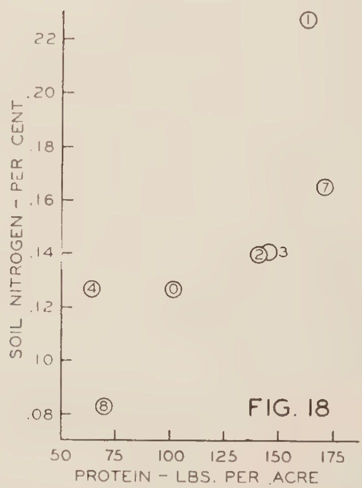


FIG. 13. Relationship between the degree of base saturation of first bottom soils and concentrations of protein in Sudan grass.

FIG. 14. Relationship between the degree of base saturation of upland soils and concentrations of protein in Sudan grass.

FIG. 15. Relationship between soil nitrogen in first bottom soils and concentrations of protein in Sudan grass.

cernable relationship between the base exchange capacity of the first bottom soils and the percentage of protein in the crop nor the yield of protein in pounds per acre. The data presented in figure 9 shows that a strongly positive correlation exists between the base exchange capacity of the upland soils and the percentage of protein in Sudan grass. A positive correlation between the yield of protein and the base exchange capacity of the soil is evident from figure 10. This later correlation is especially evident since the base exchange capacity is positively related to the yield of dry matter (5) as well as to the concentration of protein in the tissue.

Figure 11 shows that when the data for the percentages of protein in the crops from both groups of soils are pooled, a regular relationship exists between the percentage of protein in Sundan grass and the base exchange capacity of the soils. If the data for the total yield of protein are pooled, figure 12 shows that no regular relationship is evident. This lack of relationship is due to the difference between the effects of the first bottom and upland soils on the yield of dry matter.

Degree of base saturation: The data presented in figures 13 and 14 show that there is no evident relationship between the protein content of Sudan grass and the degree of base saturation of either the first bottom or upland soils. When the data are pooled, an equally irregular distribution of the data is obtained. It was shown previously (5) that the yield of dry matter was unrelated to the degree of base saturation, and it follows therefore that the total yield of protein also would be unrelated to this characteristic of the soil.

Nitrogen: It is difficult to recognize in figure 15 a definite relationship between the percentage of protein in Sudan grass grown and the amount of nitrogen in first bottom soils, although figure 16 shows that a positive relationship exists between the yield of protein in pounds per acre and the amount of nitrogen in these soils. This relationship to the yield of protein is due to the effects which the nitrogen exerted on the yield of dry matter.

On the other hand, a clearly positive correlation is shown by figure 17 to exist between the amount of nitrogen in the soil and the percentage of protein in the Sudan grass grown on the upland soils. Figure 18 shows the existence of a strongly positive relationship between the yield of protein in the Sudan grass grown on the upland soils and the amount of nitrogen in the soil. This positive correlation is to be expected since the amount of nitrogen in the soil increased both the yield of dry matter and the percentage of protein in the crop.

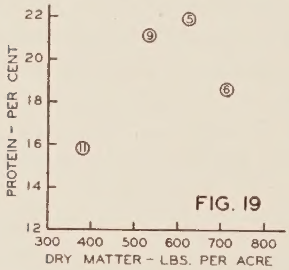
FIG. 16. Relationship between soil nitrogen in first bottom soils and yields of protein by Sudan grass.

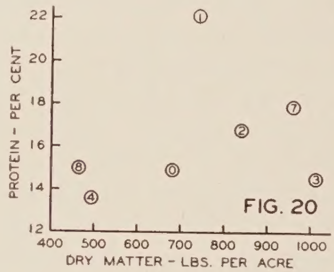
FIG. 17. Relationship between nitrogen in upland soils and concentrations of protein in Sudan grass.

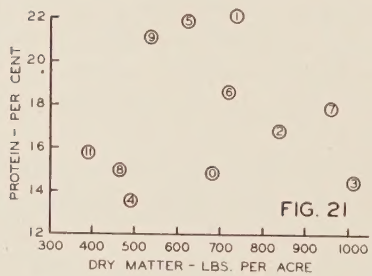
FIG. 18. Relationship between nitrogen in upland soils and yields of protein by Sudan Grass.

RELATIONSHIPS BETWEEN CROP RESPONSES

Relationships between yield of dry matter and percentage of protein: The data discussed above show that often the same factors which increased the dry weight of Sudan grass (5) also were associated with the higher percentage of protein in the tissue, which suggests that the yield in dry matter and the percentage of protein may be positively correlated in some groups of data. Figure 19 is difficult to interpret since the location of points 6 and 11 determine whether the correlation is negative or positive. Figure 20 is







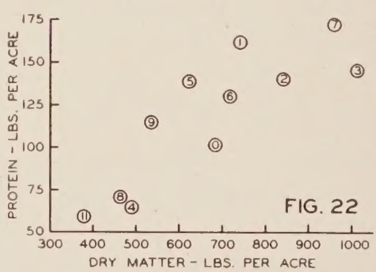


FIG. 19. Relationship between concentrations of protein and yields of dry matter by Sudan grass grown on first bottom soils.

FIG. 20. Relationship between concentrations of protein and yields of dry matter by Sudan grass grown on upland soils.

FIG. 21. Relationship between the pooled data of the yields of dry matter and concentrations or protein in Sudan grass grown on first bottom and upland soils.

FIG. 22. Relationship between the pooled data of the yields of protein and of dry matter by Sudan grass grown on first bottom and upland soils.

subject to a clear interpretation however, if it is recalled that the soil of field 301 was exceptionally rich in nitrogen. This high percentage of nitrogen produced an unusually high percentage of protein in the crop. Further, the crop from field 303 was harvested at an advanced stage of growth which caused the yield of dry matter to be too large in comparison with the other yields from the soils in the upland group.

Figure 21 shows that there is no discernible relationship between the

yield of dry matter and the concentration of protein in the crop when the data for the two classes of soils are pooled.

Relationship between yield of dry matter and yield of protein: The pooled data obtained from both groups of soils are shown by figure 22 to exhibit a strongly positive correlation between the yield of dry matter and the yield of protein in the Sudan grass.

Summary

1 A group of 10 soils in the vicinity of Midland, Douglas County, Kansas, were studied in respect to the associations which existed between the replaceable bases, base exchange capacity, base saturation, and nitrogen and the percentage of protein and the yield of protein in Sudan grass. These soils were loosely grouped into "first bottom" and "upland" soils.

2. A positive correlation existed between the amount of replaceable bases in both first bottom soils and upland soils and the percentage of protein in the crop. This relationship is accentuated when the data for both groups of soils were pooled. This highly positive correlation shows that the 2 groups of soils exert a similar effect on the protein content of the tissue.

3. A strongly positive correlation between the total yield of protein in pounds per acre and the amount of replaceable bases in the soil was also observed. This situation is to be expected since both the yield of dry matter and the percentage of protein in the crop were positively related to the amount of replaceable bases in the soil. This correlation disappears if the data for both groups of soils are pooled, which indicates that the 2 groups of soils affect growth differently.

4. A positive correlation existed also between the percentage of protein in the Sudan grass and the base exchange capacity. This relationship was maintained when the data for the 2 groups of soils were pooled. This correlation was dependent on the fact that the base exchange capacity largely determines the amount of replaceable bases and also of nitrogen in these soils.

5. A positive correlation also existed between the amount of protein produced in pounds per acre and the magnitude of the base exchange capacity.

6. The degree of base saturation is unrelated to both the percentage of protein and the total yield of protein in Sudan grass.

7. The amount of nitrogen in the soil was positively correlated with the percentage of protein in the tissue.

8. The amount of nitrogen in the soil was also positively correlated with the yield of protein in pounds per acre. This relationship was especially evident since both the yield of dry matter and the percentage of protein in the tissue were positively related to the amount of nitrogen in the soil.

9. The yield of dry matter was positively correlated with the percentage of protein in the tissue. This relationship disappears if data from both groups of soils are pooled because the effect of the 2 groups of soils on the yield of dry matter was different.

10. The total yield of protein was determined by the yield of dry matter rather than by the percentage of protein in the tissue.

11. There is evidence that groups of soils (i.e., first bottom and upland) in the area of Midland may affect some aspects of plant response similarly (i.e., percentage of protein in Sudan grass) and such data may be pooled therefore in establishing correlations between soil factors and crop response. On the other hand, these groups of soils affect other aspects of plant response differently (i.e., growth of Sudan grass) and therefore the data may not be pooled in an attempt to detect correlation between soil factors and crop response.

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